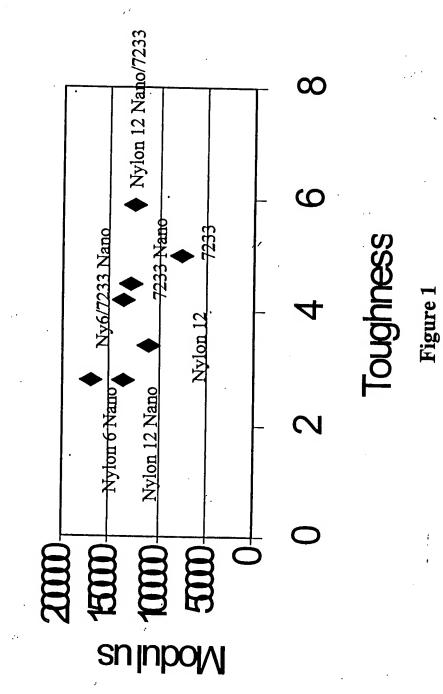
Modulus vs Toughness



Nylon Nanocomposite Versus Standard Nylon Tubing

Effect of
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++ Much Improved	Barrier Properties	Surface Properties	Mechanical Properties
+ Slightly Improved	Gas Barrier Solvent Resistance Aroma Barrier UV Barrier	Dirt Retention Printability Lubricity	Durometer (Modulus) Burst Pressure Tensile Strength Tensile Elongation Tear Strength Heat Resistance (HDT) Dimensional Stability
 Not Improved 	+++‡	+ + +	‡ ‡ + 1 + + ‡

Figure 2

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Nylon 12, Nylon 12 Nano, Pebax 7233, and Pebax 7233 Nano

Property Tensile Modulus Tensile Str. @ Break Elongation @ Break Hardness	ASTM Test Method D638 (psi) Young D638 (psi) D638 (%)	Nylon 12 Aesno TL 260,000 6800 256	Nylon 12 Nano 5% 142 312,000 6800 329		Pebax 7233 Pebax 7233 Nano 5% I ² 134,000 208,000 4785 5400 458 464 D70 D72
ensile Str.	D638 (psi) D638	6800 256	(A) O	5800 529	0
Hardness Shore D	D2240	D74		D78	
Melting Pt.	D3418 (deg C)	179	•	178	178 172
Specific Grav.	D792 (g/cc)	1.02	—	1.04	

*Increase of Stiffness and Ductility on Injection Molded Tensile Bars *I42 is the nanoparticle from Nanocor fully designated I.42.TC

Figure 3

3/8

Property	ASTM Test Method	Nylon 12 Aesno TL	Nylon 12 Nano 5% 142	Pebax 7233	Pebax 7233 Nano 5% 142
Tensile Modulus	D638 (psi) Young	110,000	136,000	75,000	127,000
Tensile Str. @ Max. load	D638 (psi)	8600	5500	11,000	9000
Elongation @ Break	D638	396	500	456	502
Tens strength x Elong @ break	(x 1,000,000)	3.4	2.8	5.0	4.5
Melting Pt.	D3418 (deg C)	179	178	172	172
Specific Grav.	D792 (g/cc)	1.02	1.04	1.02	1.03
Dimensional Stability	bility	I	‡	l	‡
*Increased Stiffness and Ductility Plus With Dimensional Stability and Improved Surface			+		+

^{*} Control of modulus from 75,000 to 136,000 all at similar melting points Figure 4

TOOTTOES TIEST

Nylon 11, Nylo	n 11 Nano, Pel	Nylon 11, Nylon 11 Nano, Pebax 2533, and Pebax 2533 Nano	bax 2533 Nano	1	6F Catheter Tubing
Property	ASTM Test Method	Nylon 11 Besno TL	Nylon 11 Nano 5% I42	Pebax 2533	Pebax 2533 Nano 5% I42
Tensile Modulus	D638 (psi) Young	112,000	134,000	<5000	<5000
Tensile Str. @ Max. load	D638 (psi)	12,600	7400	i	
Elongation (a) Break	D638 (%)	462	462	>500	>500
Tens strength x Elong @ break	(x 1,000,000)	5.8	3.4	•	,
Melting Pt.	D3418 (deg C)	190	190	ı	
Specific Grav.	D792 (g/cc)	1.03	1.05	1.01	1.02
Dimensional Stability	bility	ı	‡	1	+
Dirt Retention		ŧ	‡	1.	+
	- ::	Figure 5	U I		

TOSET" SESTROOT

Nylon 12 Nano, Pebax 7233, Nylon 12 Nano/7233, and Pebax 7233 Nano 6F Catheter Tubing

Property	ASTM Test Method	Nylon 12 Nano 5% 142	Pebax 7233	Nylon 12 Nano/ Pebax 7233	Pebax 7233 Nano 5% I42
Tensile Modulus	D638 (psi) Young	136,000	75,000	124,000	127,000
Tensile Str. @ Max. load	D638 (psi)	5600	11,000	12,000	9000
Elongation @ Break	D638 (%)	500	456	494	502
Tens strength x Elong @ break	(x1,000,000)	2.8	5.0	5.9	4.5
Melting Pt.	D3418 (deg C)	178	172	I	172
Specific Grav.	D792 (g/cc)	1.04	1.02	1.03	1.03
Dimensional Stability	oility	‡	I	‡	‡
Dirt Retention		‡		‡	‡
*Niglan 10 Nan	- (D-L - 7777 :	*Nition 10 None/Debet 7033 to a 60/60 blood with total namena			itials someontustion of 7 FO/

"Nylon 12 Nano/Pebax 7233 is a 50/50 blend with total nanoparticles concentration of 2.5%

Figure 6



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TOSET SEETIOL

Nylon 12 Nano, Nylon 11 Nano, Nylon 12 Nano/7233, and Nylon 11 Nano/7233 6F Catheter Tubing

Dimensional Sta	Specific Grav.	Melting Pt.	Tens strength x Elong @ break	Elongation @ Break	Tensile Str. @ Max. load	Tensile Modulus	Property
bility	D792 (g/cc)	D3418 (deg C)	(x1,000,000)	D638 (%)	D638 (psi)	D638 (psi) Young	ASTM Test Method
‡	1.04	178	2.8	500	5600	136,000	Nylon 12 Nano 5% 142
‡	1.05	190	3.4	462	7400	134,000	Nylon 11 Nano 5% I42
‡ ,	1.03	1	5.9	494	12,000	124,000	Nylon 12 Nano/ Pebax 7233
‡	1.04	1	13	251	5100	113,000	Nylon 11 Nano/ Pebax 7233
	‡	D792 1.04 1.05 1.03 (g/cc) ++ ++ ++	D3418 (deg C) 178 190 — D792 1.04 1.05 1.03 (g/cc) ++ ++ ++	x (x1,000,000) 2.8 3.4 5.9 k D3418 (deg C) 178 190 - D792 1.04 1.05 1.03 (g/cc) 1.04 1.05 1.03	D638 500 462 494 (%) x (x1,000,000) 2.8 3.4 5.9 b D3418 (deg C) 178 190 - D792 1.04 1.05 1.03 (g/cc) ++ ++ ++	D638 5600 7400 12,000 (psi) D638 500 462 494 (%) x (x1,000,000) 2.8 3.4 5.9 k D3418 (deg C) 178 190 - D792 1.04 1.05 1.03 (g/cc) tability ++ ++	D638 (psi) Young 136,000 134,000 124,000 D638 (psi) 5600 (psi) 7400 12,000 D638 (p/c) 500 (psi) 462 494 X (x1,000,000) 2.8 3.4 5.9 D3418 (deg C) 178 190 - D792 (g/cc) 1.04 1.05 1.03 Hability ++ ++ ++

blend of Nylon 11 Nano/Pebax 7233 *The 50/50 blend of Nylon 12 Nano/Pebax 7233 was superior to the corresponding 50/50

Figure 7

Nylon 12 Nano, Nylon 6 Nano, Nylon 6 Nano/7233, and Nylon 6 Nano/2533 - 6F Catheter Tubing

	Nylon 6 42 Nano XA290	Nylon 6 Nan 8 Pebax 7233	o/Nylon 6 Nano /Pebax 2533	*Nylon 6 Nano/ Pebax 7233 Nano
136,000	171,000	136,000	94,000	356,000
5600	9900	10,000	10,000	13,000
500	287	415	600	. 338
(x1,000,000) 2.8	2.8	4.2	6.0	4.4
9	2.8 217, 274	1 4.2	6.0	4.4
) 2.8 C) 178 1.04	2.8 217, 274 1.12	4.2 - 1.06	6.0 - 1.06	4.4
	ASTM Test Nylon 12 Method Nano 5% I Method Nano 5% I D638 136,000 (psi) Young D638 5600 (psi) D638 500 (%)		Nylon 12 Nylon 6 Nano 5% I42 Nano XA2908 136,000 171,000 5600 9900 500 287	Nylon 12 Nylon 6 Nylon 6 Nano/Nylon 6 Nano Nano 5% I42 Nano XA2908 Pebax 7233 /Pebax 2533 136,000 171,000 136,000 94,000 5600 9900 10,000 10,000 500 287 415 600

Figure 8

*for tubing 0.022" to 0.017 "....